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Household saving and fiscal policy: evidence for the euro area from a thick modelling perspective

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Abstract

We study the relationship between fiscal policy and household saving across the euro area countries for the period 1999-2019. To this extent, we propose a thick modelling approach, which allows a vast number of model specifications in a dynamic panel setting. We find that fiscal expansions are associated with an increase in household saving rate in the euro area, which supports a partial, but not full, Ricardian equivalence channel. The relationship holds regardless of how we measure the (discretionary) fiscal policy impulse. The median saving offset across all baseline specifications is around 19% in the short run and 41% in the long run. Various robustness checks underpin the basic results, while also pointing to model and estimation uncertainty and no robust evidence for total private saving offset. Our results for the euro area are broadly in line with the literature, albeit they tend to yield a somewhat weaker evidence for the saving offset of fiscal policy, particularly in relation to earlier studies.

Keywords: household saving, fiscal policy, national budget, deficit and debt

JEL classification: D14, E62, H6

Non-technical summary

The behaviour of household saving and its relationship to fiscal policy has gained renewed interest at the onset of the COVID-19 crisis. In the euro area, the household saving ratio surged in the second quarter of 2020 on account of both forced and precautionary reasons and is forecast to remain at a relatively elevated level in 2021. The lock-down restrictions and the extreme rise in economic uncertainty are cited among the most important driving factors. The developments in fiscal policy are also linked to the increase in the household saving ratio as a high proportion of the additional income from government transfers has been saved instead of being directed to consumption.

In view of the strong calls for continuous fiscal support to macroeconomic stabilization, this paper seeks to explore in detail the relationship between fiscal policy and household savings in the euro area. First, the paper tests the robustness of fiscal policy variables in explaining the household saving ratio by employing a thick modelling framework that allows a vast number of model specifications and controls for other relevant factors identified in the literature. To capture relevant relationships between fiscal policy and household saving - from both a statistical and economic perspective (significance and size of the effect) - we use a panel dataset over the euro area period (1999-2019) for the 19 current euro area members. Second, we conduct a series of robustness checks, inter alia, to expand the framework to total private savings and verify if our conclusions stand when using estimates of discretionary fiscal policy across various institutions or when using other econometric estimators. To our best knowledge, this paper is one of the first to use a thick modelling approach to systematically investigate the behaviour of household (and total private) savings in response to fiscal policy across the euro area countries.

Our main results can be summarized as follows. First, we find empirical evidence for a partial household saving offset of fiscal stimulus, with a median value of 19% in the short run and 41% in the long run. While the magnitude of the effects varies depending on the specific fiscal policy proxy at hand, this partial offset is regardless of how we measure fiscal policy. Overall, we do not find empirical evidence for the existence of a strict version of the Ricardian equivalence in the euro area, i.e. a full saving offset of fiscal stimulus in the short run. Although some fiscal-macro combinations in our thick modelling approach do not rule out full saving offsets in the long-run, most of our fiscal elasticities are located well below unity. This supports the idea of learning about the relationship between fiscal policy and household saving by using many different model specifications.

Second, in terms of additional results and robustness checks, we find the following. Disposable income growth, real short-term interest rate, GDP deflator and household debt turn in our thick-modelling approach to be the most robust variables among a larger set of potential determinants for the household saving ratio identified in the literature. Various robustness checks – in terms of alternative data, fiscal indicators and estimators – broadly support our results with respect to household savings. On the other hand, the evidence for the relationship between fiscal policy and total private saving is weak and not robust enough in our model.

Third, our results for the euro area are broadly in line with the literature for the advanced economies, albeit they tend to yield a somewhat weaker evidence for the saving offset of fiscal policy, particularly in relation to earlier studies or as regards the total private saving offset. This may point to an increased effectiveness of fiscal policy for short-run stabilization.

The usual cautionary remarks when drawing causal inferences with macroeconomic data applies to our findings. In addition to tackling model uncertainty, we attempt to mitigate the problem of endogeneity of fiscal variables by using the Arellano-Bond GMM estimator.

Areas for future research include a more in-depth investigation of the relationship to government debt (whose impact is ambiguous in our analysis), the differences in results between household and total private saving and quantifying the role of fiscal policy versus other determinants of saving.

1. Introduction

The behaviour of household saving and its relationship to fiscal policy has gained renewed interest at the onset of the COVID-19 crisis. In the euro area, the household saving ratio surged in the second quarter of 2020 on account of both forced and precautionary reasons and was forecast to remain at a relatively elevated level in 2021 and to reach the pre-crisis level only towards end-2023 (see *ECB 2021*). The lock-down restrictions and the extreme rise in economic uncertainty are cited among the most important driving factors. Fiscal policy, through massive net fiscal transfers to households and firms, has supported household disposable income, which has fallen less than output. At the same time, fiscal positions in the euro area countries have deteriorated significantly on account of the large stimulus measures and the worsening of macroeconomic conditions. The developments in fiscal policy have been linked to the increase in the household saving ratio as a high proportion of the additional income from government transfers has been saved instead of being directed to consumption. Overall, the extraordinary stimulus measures over 2020-21, and their partial assumed unwinding as of 2022, are projected to go along with an increase, followed by a decrease, in the household saving ratio. As pointed out in *ECB (2021)*, some of the increase in the saving rate associated with precautionary motives may be harder to reverse due to expectations of households that the strongly increased public debt burden due to the pandemic might need to be addressed via higher taxes in the future.

In view of the strong calls for continuous fiscal support to macroeconomic stabilization, this paper seeks to explore in detail the relationship between fiscal policy and household savings in the euro area. First, the paper tests the robustness of fiscal policy variables in explaining the household saving ratio by employing a thick modelling framework that allows a vast number of model specifications and controls for other relevant factors identified in the literature. In doing so, we seek to identify the most robust fiscal policy variables – if any – in explaining the household saving ratio from both a statistical and economic perspective (significance and size of the effect). To capture relevant developments, we use an annual panel dataset over the euro area period (1999-2019) for the 19 current euro area members (according to data availability).[1] Second, we conduct a series of robustness checks, inter alia, to expand the framework to total private savings and verify if our conclusions stand when using estimates of discretionary fiscal policy across various institutions or when using other econometric estimators. To our best knowledge, this paper is one of the first to use a thick modelling approach to systematically investigate the behaviour of household (and total private) savings in response to fiscal policy across the euro area countries.

Our paper fits broadly into the empirical literature testing the partial Ricardian equivalence. In this vein, an expansionary fiscal policy is generally found to be associated with a higher household (private) saving rate. This partial "private saving offset" of fiscal stimulus measures is interpreted as weak evidence of the disputed Ricardian equivalence[2], according to which households

[1] We restrict the analysis before the crisis to purge one-off effects and avoid including forecast data (also due to constraints on historical data at the cut-off date of our dataset and analysis).

[2] See *Barro (1974, 1989)* and an overview of the literature in *Röhn (2010)*. According to *Barro (1989, p. 39)*, the term "Ricardian equivalence" denotes the fact that budget deficits and taxation have equivalent effects on the economy (the substitution of a budget deficit for current taxes has no impact on aggregate demand). In other words, a decrease in the government's saving (that is, a current budget deficit) leads to a *fully* offsetting increase in (desired) private saving. Since national saving does not change, the real interest rate does not have to rise in a closed economy to maintain the balance between desired national saving and investment demand, with no subsequent effect on investment and no burden of public debt. *Barro (1989)* also discusses five major theoretical objections that have been raised against the "*full*" Ricardian equivalence, namely, the assumptions of: (i) infinitely-lived agents; (ii) perfect capital markets; (iii) no uncertainty (surrounding future taxes and income); (iv) lump-sum taxes and (v) full employment. He concludes, however, that these assumptions apply

fully save the additional disposable income as a result of fiscal stimulus measures in expectations of higher taxes in the future. Most studies investigating in detail the role of fiscal policy in explaining the household saving ratio belong to the early literature and cover a larger sample of advanced economies (OECD countries). Two early IMF working papers – *Callen and Thimann (1997)* and *Tanzi and Zee (1998)* – find evidence for partial Ricardian effects of household saving in relation to higher budget deficits, lower direct taxes and higher government transfers, after controlling for a given set of other determinants of savings. Yet, results are not always fully consistent across models. For instance, *Callen and Thimann (1997)* find evidence for net transfers only in cross-country and not in panel regressions, while, contrary to the former study, *Tanzi and Zee (1998)* find evidence for indirect taxes (lower consumption tax revenue being associated with a higher saving rate). A later study (*Mody et al., 2012*) investigates the factors behind the increase in the households saving rate in the advanced OECD countries during the Great recession of 2007-2009. While the main focus of the paper is on the role of uncertainty in explaining precautionary savings, it also controls for the impact of fiscal policy using the structural budget balance. Based on estimation using an unbalanced panel sample, with the longest period covered being 1980-2010, it finds evidence of partial Ricardian behaviour, with the fiscal expansion explaining about one-fifth of the increase in the household saving ratio during the past crisis.

Studies investigating the relationship between fiscal policy and total private saving are more frequent. A more recent OECD paper – *Röhn (2010)*, expanding on previous OECD research by *De Mello et al. (2004)* and *de Serres and Pelgrin (2003)*, finds that the private saving offset of fiscal policy is around 40% on average, both for the short and long term. For the overall effect of fiscal policy, the paper uses the cyclically-adjusted budget balance, whose regression coefficient in an error-correction model is found (for both short and long run) at around 0.4 for the sample of advanced OECD countries over the period 1970-2008. The private saving offset is somewhat lower than found in prior research, particularly for the long-run.

In general, older studies tend to find a private saving offset above 50% for advanced economies over the period 1970 up to mid-90s or to mid-2000, using the budget balance or cyclically-adjusted budget balance as a proxy for fiscal policy. Over the long-run, the ratio goes up to 85-90%. Most studies distinguishing between short and long run by means of error correction or dynamic panel models find that the private saving offset is higher in the longer run in line with considerations related to fiscal policy sustainability and fading stabilisation effects. Over the short-run, the private saving offset of fiscal policy is generally found at 33-50%. The estimator used in the empirical analysis is also an important source of heterogeneity in results. In particular, using the system GMM estimator tends to produce lower estimates, as in *Loayza et al. (2000)*, which finds a private saving offset of about 11% in the short-run and 34% in the long-run for a sample of 20 OECD economies over the period mid-1960s – mid-1990s. In terms of the household saving ratio, the range of results is similar, if not even broader. *Callen and Thimann (1997)* finds a household saving offset (in relation to the headline budget balance) of 80-90% in cross-sectional regressions averaged over 1975-1995, but only around 30-37% in various fixed-effect (annual data) regressions. *Mody et al. (2012)* finds a smaller offset of 20% also using fixed effects with annual data, but in relation to the structural budget balance and for a more recent time period (ending in 2009/2010 and starting at the earliest in 1980, but for most European countries in mid-1990s). In fixed-effects

also to other models, especially the standard view of fiscal policy, according to which budget deficits lead to an expansion of aggregate demand (or partial private saving offset). Finally, he quotes several empirical studies (natural experiments for a single country or two-country comparisons) that found a full (one-to-one) private saving offset of a budget deficit expansion, while at the same time calling for more analysis, especially in an international context.

regressions using 3-year annual averages, the ratio increases from 21% to 54%. For a detailed overview of the findings in relevant empirical studies, see Table A1 in the appendix.

Our paper also belongs to the thick modelling strand of empirical research, which allows the estimation of a vast number of model specifications (see *Granger and Jeon 2004*). In this respect, two papers are closely related to ours, namely *Ca'Zorzi et al. (2012)* and *De Bondt et al. (2020)*. Both employ a thick modelling strategy while indirectly controlling for fiscal factors and the Ricardian equivalence. In contrast, the fiscal policy effects are at the core of our analysis.

In terms of the econometric approach, our paper is most closely related to *Ca'Zorzi et al. (2012)*. The authors investigate the determinants of the current account balance (or total net external savings), including those related to fiscal policy proxied by the budget balance. The authors propose, as we do, to consider unique permutations of fourteen prior identified explanatory variables to find the most robust fundamentals explaining the current account balance in a panel of developed and emerging countries. Out of thousands of resulting alternative specifications, the authors suggest combining the estimated level elasticities resulting from each unique specification using a weighted model averaging approach.[3]

Most recently, *De Bondt et al. (2020)* develop a thick modelling tool for real private consumption, focusing on disaggregated income and wealth effects, with an application to the euro area aggregate (using quarterly time series for the period 1999Q1–2017Q3).[4] Among selected models, the authors average estimated coefficients using equal weights.[5] The model controls for Ricardian equivalence in fiscal policy using several variables at the euro area aggregate level (government debt and government balance – both in levels and changes, as well as quarterly growth rate of real government consumption). While not directly the focus of their paper, the authors conclude that Ricardian effects are typically picked up in the selected models by changes in the budget balance.

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Second, in terms of additional results and robustness checks, we find the following. Disposable income, real short-term interest rate, GDP deflator and household debt turn in our thick-modelling approach to be the most robust variables among a larger set of potential determinants for the

[3] To be more precise, they average OLS coefficients justified from a Bayesian perspective by using weights determined by the posterior probability of each model (Bayesian averaging using Classical Estimates approach). The weights are a function of the goodness of fit of the model and a degrees-of-freedom correction.
[4] For other early applications of thick modelling see *McAdam and McNelis (2004)* or *Aiolfi and Favero (2005)*. For similar thick modelling applications to the one proposed in this paper see *De Bondt et al. (2019)*.
[5] In total, they construct around 30,000 consumption equations of which they select 59 after applying a five-step model selection procedure. The model selection is sequentially based on three in-sample, one theoretical and two out-of-sample criteria. Note that the theory-based criterion requires estimated coefficients to have an economically correct sign.

household saving ratio identified in the literature. Various robustness checks – in terms of alternative data, fiscal indicators and estimators – broadly support our results with respect to household savings. On the other hand, the evidence for the relationship between fiscal policy and total private saving is weaker in our model.

Third, our results for the euro area are broadly in line with the literature, albeit they tend to yield a somewhat weaker evidence for the saving offset of fiscal policy, particularly in relation to earlier studies or as regards the total private saving offset.

The rest of the paper is organized as follows. Section 2 describes our fiscal and macroeconomic variables. Section 3 introduces the thick modelling framework and our estimation strategy. We interpret our main results in section 4 and section 5 follows with a battery of robustness tests. Section 6 concludes.

2. Data

Our sample covers the period 1999 – 2019 at annual frequency for the 19 Euro Area countries, namely Austria, Belgium, Cyprus, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Latvia, Luxembourg, Lithuania, Malta, Netherlands, Slovenia, Portugal and Slovakia. Most of the data is taken from the ECB, European System of Central Banks (ESCB) estimates for the cyclically adjusted fiscal variables, European Commission and Eurostat. For details on data, see Table A2 and A3 in the appendix.

The dependent variable in our main regression analysis is the ratio of household saving to nominal household disposable income. Chart A1 in the appendix plots the household saving ratio by country.[6] To capture the effect of fiscal policy, we employ several variables. In the main specification, we use budget balance, primary balance, cyclically adjusted primary balance and structural balance. Negative values refer to fiscal deficits. The primary balance measures headline budget balance excluding interest payments. Changes in these headline variables capture total fiscal impulse, including automatic stabilizers. Cyclically adjusted variables net out the impact of the economic cycle, but they are estimates, un-observables in practice and surrounded by uncertainty. The change in the cyclically adjusted primary balance is a common indicator of the fiscal policy stance, equivalently, a (top-down) measure of discretionary fiscal policy. The structural indicators purge the fiscal stance from the influence of temporary one-offs. All fiscal items, but especially cyclically adjusted or structural balances, are important indicators to gauge changes in fiscal positions. However, a-priori favoring one over the other to capture the effects of fiscal policy onto household saving is challenging. In the robustness checks, we use a large set of other fiscal variables, including budget subcomponents, a bottom-up measure of discretionary fiscal policy, and government debt.

Household saving decisions are affected by various other factors. To control for their impact in our empirical analysis we use a set of macroeconomic, as well as financial, wealth, demographic and confidence indicators, which are commonly studied in the empirical literature. Traditional business cycle controls include real GDP growth, output gap, gross disposable income growth, unemployment rate, and price growth, while productivity effects are reflected in the growth rates of total factor productivity and terms of trade of goods and services. Financial and wealth effect

[6] The data depicted in the chart originates from the European Commission's AMECO database. It does not contain data for Malta. In our empirical analysis, we use ESCB data, which includes internal estimates for the household saving rate from the National Bank of Malta.

considerations can be captured by the short-term real interest rate, long-term nominal interest rates, household sector debt and the national equity market indices. Demographic effects are captured in our analysis by the old-age dependency ratio, i.e. population over 65 years of age as percent of total population, as well as the total population growth. Lastly, forward-looking subjective beliefs about future macroeconomic developments or confidence effects are hereby proxied by the (European Commission's) Economic Sentiment Indicator.

In total, we collect fourteen possible predictors, apart from fiscal policy. Again, our focus lies on the reaction of saving to fiscal policy. Thus, we mainly include macroeconomic and other variables to control for their effect on saving when we analyze the fiscal measures of interest. This allows us to remain agnostic about the specific relationship involving these macro variables. Restricting ourselves to only a few selected models based on a-priori specified criteria might be misleading as either statistical or, in particular, economically motivated criteria (see, for example, *De Bondt et al. 2020*) could be too tight. In addition, referring to the discussions provided in the literature, see e.g., *De Mello et al. (2004)*, *de Serres and Pelgrin (2003)*, *Hüfner and Koske (2010)*, *Röhn (2010)*, theoretical discussions about the significance and sign of macroeconomic and other control variables are in many cases ambiguous. This being said, the topic remains relevant and we report on the most robust variables found in our thick-modelling approach.

Overall, we have an unbalanced panel, but the coverage of data for the euro area period is very good for most countries and for our variables of interest. This is also one of the reasons for restricting the sample to start in 1999.

3. Econometric methodology and estimation

In order to test empirically the relationship between fiscal policy and saving, we specify the following dynamic panel data model which is assumed to have generated $y_{i,t}$:

$$y_{i,t} = c + \alpha_i + \varphi\, y_{i,t-1} + \gamma^{SR}\, fp_{i,t} + M_{i,t}^{s}\, \beta + u_{i,t}\ ,$$

where $t = \{1, \dots, T\}$ and $i = \{1, \dots, N\}$. $y_{i,t}$ is the dependent variable measuring the household saving ratio observed for individual country i at time t, while $fp_{i,t}$ refers to one candidate proxy for fiscal policy. Most important in this paper is the coefficient γ^{SR}, which measures the short-run impact of fiscal policy on savings conditional on lagged savings $y_{i,t-1}$, as well as macroeconomic and other information ($M_{i,t}^{s}$). The long-run fiscal effect is then implicitly determined by $\gamma^{LR} = \gamma^{SR}/(1-\varphi)$. If the Ricardian equivalence hypothesis were to hold in the data, we would expect γ^{SR} to be statistically significant and negative (lower budget balances or expansionary fiscal policy associated with higher household saving). Partial Ricardian equivalence would also imply a value different from -1 so that $-1 < \gamma^{SR} < 0$.

The $k\ x\ 1$ dimensional vector $M_{i,t}^{s}$ contains a subset of additional macroeconomic fundamentals commonly studied in the literature employed as controls. The scalars c, a_i and $u_{i,t}$ are the constant, unobserved time-invariant individual fixed effect and the serially uncorrelated idiosyncratic error term.

In order to capture model uncertainty, we propose a thick modelling approach (*Granger and Jeon 2004*) in the spirit of *Ca'Zorzi et al. (2012)* and *De Bondt et al. (2020, 2019)*. This empirical method allows estimating a broad range of model specifications rather than relying on a single best one. A constraint in estimating the relationship between savings and fiscal policy is the selection of macro fundamentals and other potentially relevant predictors. This gives rise to the well-known curse of dimensionality. Using all potential macro variables lowers degrees of freedom and especially including highly correlated regressors raises estimation uncertainty reflected in larger standard errors. In contrast, using too few explanatory variables is at risk of introducing omitted variable bias. For this reason, in contrast to *Ca'Zorzi et al. (2012),* we only consider unique subsets M^s out of all possibly relevant fundamentals, i.e. $M^s \subset M$ where $M^s \in \mathbb{R}^k$, $M \in \mathbb{R}^K$ and $k \ll K$. This approach is, for example, in line with *De Bondt et al. (2020, 2019)*, who allow for a distinct combination of four macro controls.

Although such a thick modelling strategy prohibits all possible macroeconomic fundamentals to enter the model jointly, we do however consider *distinct* combinations of all k variables contained in the full $\mathbb{R}^K$-dimensional vector of macro controls. Thus, we estimate $j = \{1,\ldots,J\}$ models, i.e. $\mathcal{M}(j)$ refers to some model $1 \leq j \leq J$ using only the j-th distinct subset $M_{i,t}^s(j)$ of all available macro variables.

We see at least three advantages: First, this modelling strategy circumvents the curse of dimensionality by reducing the (maximum) model size, thus the number of estimated coefficients, from $K + 3$ to $R + 3$, where R marks the upper threshold of allowed variable combinations such that $k = \{1,\ldots,R\}$ with $k \leq R \ll K$. Second, this approach still allows us to control for and analyse various macroeconomic, financial and demographic effects. Third, the approach enables us to address the uncertainty about the fiscal impulse onto saving by taking into account the information stemming from thousands of fiscal elasticities – calculated in a similar manner, i.e. without mixing different variable units - conditional on various fiscal-macro combinations rather than relying on a single best or a handful of specifications only.

Given our relatively small sample for both dimensions N and T as well as for computational reasons, we restrict a-priori the model size to contain six other predictors at maximum, i.e. $R = 6$. This threshold reduces the dimension of the largest possible models roughly by one-half while still allowing for a reasonably large number of additional controls to be included. We will always include the fiscal policy proxy as well as one lag of the dependent variable as explanatory variables.

To be more precise, the most parsimonious models will include one lag of the dependent variable, the fiscal policy measure of interest at time t as well a single control variable also dated at time t. Given our fourteen macro and other controls at hand, this also yields fourteen models of minimum size. We then proceed by allowing for two distinct combinations of control variables, which yields 105 models in addition to the fourteen previous ones. We then sequentially increase the number of controls until six such that the most complex models include the lagged dependent and contemporaneous fiscal policy variable as well as a distinct combination of six macro fundamentals dated at time t, which again yields 3,003 additional models. For each estimated model $\mathcal{M}(j)$ we collect the resulting parameters of interest. For our main variable of interest, a candidate measure of (discretionary) fiscal policy always included, one obtains 6,475 $\hat{\gamma}(j)$ coefficients and corresponding standard errors, i.e. $j = \{1, \ldots, J = 6{,}475\}$. For each macro control we obtain 1,980 $\hat{\beta}(j_s)$'s, plus standard errors whenever it appears in one of the regression models. Following *Granger and Jeon (2004)*, we safeguard against extreme outliers and further trim the vector of estimated short-run fiscal coefficients ex-post by discarding five percent at each tail of the distribution for each variable, i.e. $\tau = 0.1$ denotes the ex-post trimming parameter. Finally, we apply what *Granger and Jeon (2004)* refer to as a simple thick modelling strategy and pool the various estimates (coefficients and standard errors/t-values) from each unique ‘thin’ specification using the median.[7]

The dynamic panel data model, accounting for inertia and momentum, includes lagged dependent variables as regressors, which violates the strict exogeneity assumptions by definition, i.e. $E[\alpha_i\ ,\ y_{i,t-1}] \neq 0$. A standard estimation approach in dynamic panel settings is the generalized method of moments approach (*Arellano and Bond, 1991*; *Arellano and Bover, 1995*; *Arellano, 1998*; *Blundell and Bond, 1998*). For our data, we favour the standard one-step difference GMM (FD-GMM) estimator of *Arrelano and Bond (1991)*. First, fixed-effects are removed by first-differencing the model, which implies $E[\Delta y_{i,t-1}\ ,\ \Delta u_{i,t}] \neq 0$. FD-GMM builds on the moment conditions $E[u \mid z] = 0$ and exploits the fact that the number of valid instruments z grows with t.[8] Thus, in a second step, deeper lags of the endogenous and predetermined variables are employed as valid instruments starting with $t \geq 3$ without further reducing the sample size, which is already relatively small in our empirical application. Compared to other estimation techniques utilizing a similar instrumental variable approach, e.g. *Anderson and* Hsiao *(1981, 1982)*, the difference (one-step) GMM estimator thus provides a more efficient estimation strategy.[9]

Given our small sample we collapse the possibly large instrument set, i.e. a lag-unrestricted Z_i is at least of size $(T-2)\ x\ L$, where $L = \sum_{t=1}^{T-2} t$. As noted by *Roodman (2009a, 2009b)* too many instruments might overfit the endogenous variable(s) which then fails to expunge their endogenous components. Collapsing the instruments, i.e. Z_i is now a lower-triangular matrix of size $(T-2)\ x\ (T-2)$, still embodies the same expectation, i.e. $E[Z_i'\ ,\ \Delta u_i] = 0$, but conveys slightly less information. In addition, the lower dimension of Z_i reduces computational burdens, which is another salient feature given our thick modelling strategy.

4. Empirical results: baseline specification

4.1. Results with models across all basic fiscal variables

Before turning to individual results for each fiscal policy variable, we consider the whole range of estimated models resulting from applying our thick modelling strategy to each fiscal variable. Figure 1 presents a scatter plot of our estimated coefficients across all four baseline candidate measures for (discretionary) fiscal policy, i.e. budget balance, primary balance, cyclically adjusted primary balance and structural balance. These fiscal items are always included, each at a time, in every estimated model. Panel A plots our short-run coefficients and Panel B refers to the corre-

[7] To this extent, our simple thick modelling strategy does not account for model and estimation uncertainty jointly. In order to account for both, *Granger and Jeon (2004)* propose the use of bootstrap aggregation techniques to form confidence intervals for the combination of alternative specifications. However, this would require re-estimating the parameters many times (up to a few hundred or thousand) based on a random (residual-based) resampling of the data for each of our 6,475 unique specifications. Given that the computational complexity for our current thick modelling approach is already relatively high, we abstract from the bootstrap approach.

[8] In fact, the number of valid instruments is quadratic in T.

[9] *Ca'Zorzi et al. (2012)* rely on a dynamic panel model, but favor a compromise between purely static and dynamic estimation of the level elasticities. They argue to filter high-frequency movements by non-overlapping moving averages and proceed estimating a static relationship by means of pooled OLS between filtered variables. They combine OLS coefficients justified by a Bayesian model averaging of classical estimates approach. However, results may critically depend on the window length used for averaging (and the prior about the model size), which is why we rely on standard GMM techniques to estimate our dynamic panel model. We do, however, acknowledge that Arellano-Bond difference GMM is mainly suitable for both fixed T and $N \to \infty$, but check our results in the robustness section using a static fixed-effect estimator.

sponding model-implied long run coefficients (results for the autoregressive component are provided in the appendix). To this end, Figure 1 summarizes 23,308 trimmed models (out of 25,900 untrimmed), i.e. 5,827 trimmed models for each fiscal measure. Note that our trimming procedure is based on the short-run fiscal elasticities and, thus, Panel B refers to the model-implied long-run elasticities based on auto-regressive and short-run parameters corresponding to trimmed elasticities shown in Panel A.

Here, we mainly consider the underlying model uncertainty as in some regressions the employed set of instruments may turn out invalid or individual models may fail the Arellano-Bond autocorrelation tests. These may be serious sources of model misspecification from a statistical perspective. Nevertheless, for both panels there seems to be a clear tendency towards negative values, i.e. the sign of the coefficients appears relatively robust across all specifications. Compared to other thick modelling studies, which only allow significant and/or "correctly" signed elasticities from (a chosen) theoretical perspective to enter the final distributions based on economic reasoning, at this stage we let the data decide about the economic and statistical importance of fiscal elasticities.

Across all baseline fiscal variables, the estimated range of short- and long-run fiscal multipliers with respect to household saving, $\hat{\gamma}^{SR}(j)$ and $\hat{\gamma}^{LR}(j)$, shows that most of the elasticities are located well below zero.

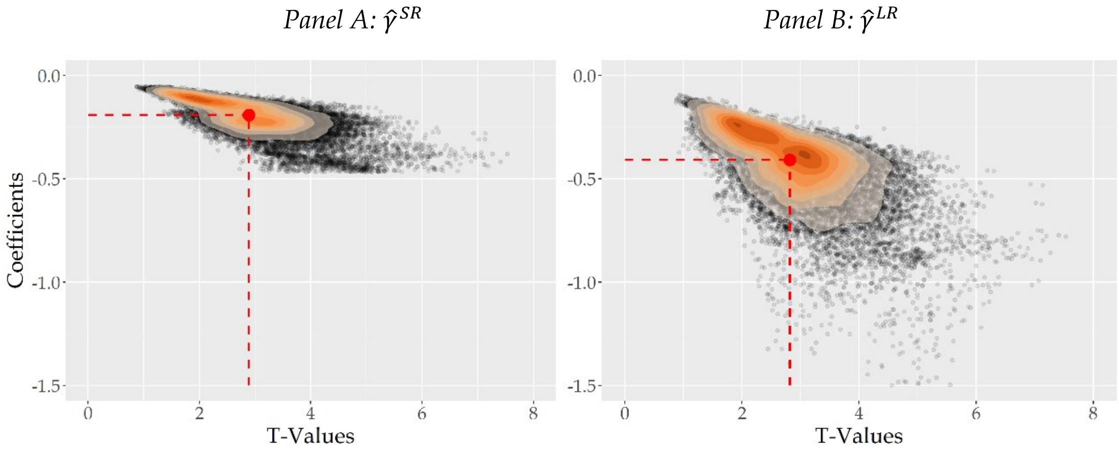
Short-run elasticities are found to be bounded somewhere between -0.05 and -0.47 (90% range between -0.09 and -0.36) conditional on the specific fiscal-macro combination.[10] This reflects our model uncertainty only, but points to the fact of substantial heterogeneity across different model specifications. The median short-run fiscal elasticity is around -0.19. In addition, most of the models yield fiscal elasticities with t-values greater than two, which underpins the statistical importance of fiscal items. We also add a layer for the estimated joint bivariate kernel density (orange shaded region) on top of the scatter plot which gives an indication of local clusters in the coefficient distribution.[11] Most short-run elasticities seem to be clustered around -0.13, but there is also some clustering at -0.22. Hence, combining information from all models indicates a short-run effect of fiscal policy onto household savings, i.e. fiscal expansions in the euro area lead to an increase in the gross household saving ratio regardless of how we measure fiscal policy. This is in line with the existence of a (partial) Ricardian equivalence channel or a partial saving offset of fiscal stimulus.

The distribution of the model-implied long-run fiscal elasticities is more dispersed. The median across all models is around -0.41 (the 90% range reflecting model uncertainty lies between -0.21 and -0.76). Again, most of the coefficients have t-values greater than two, which indicates a high degree of statistical significance for most of the models. We document coefficient clusters at -0.24 and -0.36. Table A.3 in the appendix shows that the autoregressive coefficients are estimated to lie within a range between 0.40 and 0.68. This suggests a moderate degree of persistency and supports the choice of our estimator.[12]

[10] Although we pool all four baseline fiscal balances at this stage, they are all measured in percent of GDP and estimated conditional on the same control variables, with distinct permutations. Thus, all elasticities measure the fiscal impulse in percent of GDP on gross household saving as percent of disposable income.
[11] Note that both the scatter and kernel density plots are purely presentational devices to summarize all possible outcomes from our simple thick modelling approach. We are thankful to an anonymous referee, who correctly pointed out that our non-parametric distributions of the coefficients and their corresponding t-values can only be interpreted without (joint) inferential implication. This is because we do not report bootstrapped confidence intervals which treat model and estimation uncertainty jointly. To summarize our results, we apply a simple thick modelling method by pooling (with equal weights) all available thin specifications using the median after applying an outlier correction (see *Granger and Jeon 2004*).
[12] In the presence of a highly persistent dependent variable, the *Arellano and Bond (1991)* estimator usually performs poorly (see *Blundell and Bond 1998)*.

Overall, there seems to be substantial support for a partial saving offset of fiscal stimulus in line with a Ricardian channel with median offsets at 19% and 41% in the short- and long-run respectively (mean at 20% and 44%). Although some fiscal-macro combinations in our thick modelling approach do not rule out full saving offsets in the long-run, most of our fiscal elasticities are located well below unity. Thus, according to our data and modelling choice, we reject existence of a strict version of the Ricardian equivalence.

Figure 1: Distribution of fiscal elasticites and t-values across all trimmed models (baseline)



Source: Authors' calculations. Notes: This figure plots estimated coefficients (y-axis) against their corresponding t-values (x-axis), as well as their their joint normalized bivariate kernel density using a Gaussian kernel and a rule-of-thumb selected bandwith parameter. All models estimated with Arellano-Bond GMM. The dependent variable is gross household saving as a percentage of disposable income. Fiscal variables (budget balance, primary balance, cyclically-adjusted primary balance and structural balance, all measured in percent of GDP) introduced one at the time in each model and treated as endogenenous. Panel A refers to estimated short run fiscal policy coefficients and corresponding t-values. Panel B plots model-implied long run fiscal policy coefficients and t-values. The number of trimmed models is 23,308 (untrimmed 25,900, with $\tau = 0.1$). Red dashed lines refer to the medians.

4.2. Results with individual fiscal variable models

Next, we disentangle the pooled distribution and turn to our results for individual fiscal variables (see Table 1 and A3 in the appendix). Panel A of Table 1 shows the estimates for all trimmed models, while panel B performs a model selection exercise, in which we only accept statistically well specified models. In this respect, we first require the models to pass the Sargan test, i.e. employed instruments as group are valid. Second, models must pass the Arellano-Bond autocorrelation tests for residuals, i.e. first-differenced residuals should display first-order autocorrelation by construction, but no second-order residual autocorrelation.

Overall, there seems to be strong empirical support for an effect of fiscal policy on household saving in line with a partial Ricardian equivalence channel, regardless of how fiscal policy is measured exactly. At five percent level almost all models yield significant negative short-term elasticities regardless of how we measure fiscal policy. The significance ratios vary between 74 and 97% depending on the specific fiscal measure. Up to 80% of models pass jointly the Sargan and Arellano-Bond tests.[13] The coefficients for the selected models are, overall, only marginally higher in absolute value than those for all trimmed models.

For the most broadly defined fiscal policy proxy, the headline budget balance, the median short-run elasticity is around -0.18 in the selected models, while the long-run this effect is larger at -

[13] The ratio of models jointly rejecting the Arellano-Bond residual autocorrelation and Sargan tests drops to below 60% for the structural balance.

0.42. For this fiscal indicator, 76.1% of all trimmed models are selected (4,437 out of 5,827 models). In most of the models (94%), the short-run coefficient is found statistically significant.

Excluding interest payments, that is, looking at the primary balance, we find similar yet slightly smaller results. The median short (long) run elasticity is around -0.15 (-0.35) in the selected models. These results only marginally differ between selected models versus all trimmed models (0.14 and 0.33).

Table 1: Median fiscal elasticities (baseline)

	Panel A: All Trimmed Models				*Panel B: Selected Models*			
	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	$JR_{10\%}$	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	*NoM*
Budget balance	-0.175	-0.400	91.4	76.1	-0.181	-0.418	93.7	4,437
Estimation uncertainty	*(0.060)*	*(0.135)*			*(0.059)*	*(0.138)*		
Model uncertainty	*-0.28/-0.11*	*-0.59/-0.26*			*-0.28/-0.11*	*-0.60/-0.28*		
Primary balance	-0.144	-0.334	73.8	79.3	-0.149	-0.347	73.9	4,620
Estimation uncertainty	*(0.060)*	*(0.129)*			*(0.060)*	*(0.134)*		
Model uncertainty	*-0.24/-0.07*	*-0.53/-0.17*			*-0.24/-0.07*	*-0.53/-0.17*		
Cyclically adjusted primary balance	-0.145	-0.329	78.2	79.4	-0.147	-0.345	80.7	4,627
Estimation uncertainty	*(0.058)*	*(0.134)*			*(0.058)*	*(0.137)*		
Model uncertainty	*-0.24/-0.08*	*-0.56/-0.19*			*-0.25/-0.08*	*-0.56/-0.19*		
Structural balance	-0.279	-0.615	97.4	57.1	-0.284	-0.654	98.9	3,328
Estimation uncertainty	*(0.085)*	*(0.184)*			*(0.082)*	*(0.185)*		
Model uncertainty	*-0.44/-0.19*	*-0.96/-0.42*			*-0.45/-0.19*	*-1.02/-0.46*		

Source: Authors' calculations. Notes: The table presents the medians of estimated fiscal elasticities and their robust standard errors in parentheses from the trimmed coefficient distributions using $\tau = 0.1$ (fiscal balances measured as percent of GDP). Standard errors for the model-implied long run coefficients were computed using the Delta-method. Model uncertainty refers to 5th and 95th quantile of the estimated coefficient distribution. The dependent variable is gross household saving as a percentage of disposable income. Fiscal variables were treated as endogenous. Panel A refers to all estimated trimmed model specifications (5,827 models for each fiscal measure). Panel B discards statistically mis-specified models. It selects only those models which jointly pass both Arellano-Bond autocorrelation tests (i.e. existence of first- but no second-order autocorrelation of residuals in first differences) as well as models passing the Sargan test for overidentifying restrictions (H_0: Instruments as a group are exogenous). $SR_{5\%}$ refers to the significance ratio, i.e. the share of significant short run fiscal policy coefficients (with p-value lower than 5%). $JR_{10\%}$ refers to the ratio of models with (i) Arellano-Bond first-, (ii) but no second-order residual autocorrelation (both at 10% p-values) as well as (iii) Sargan overidentifying test p-values greater than 10%. NoM refers to the number of models remaining after model selection. The number of total observations, across both N and T, in our regressions using an unbalanced panel varies between 292 and 358 depending on data availability.

Interestingly, when looking at the proxies for discretionary fiscal policy, we get similar estimates for the cyclically-adjusted primary balance (-0.15 and -0.35), but find larger effects when turning to the structural balance, which in addition to the business cycle also account for temporary one-offs (-0.28 and -0.65). This may imply that a permanent stimulus affects household decisions more than a temporary one.

As pointed out by *De Bondt et al. (2020)*, each thin specification may include control variables that can be correlated. Hence, our results are also dependent on the specification and interaction among right-hand side variables. In order to check the possible impact of additional macro variables for our conditional fiscal elasticities, we also ran four separate FD-GMM models which only included our baseline fiscal balances and one lag of the dependent variable. In other words, those specifications contain fiscal elasticities which are unconditional on any macroeconomic, financial or demographic information. The short-run fiscal elasticities were found highly statistically significant, but, somewhat surprisingly, similar in size to the reported median elasticities from Table 1. The long-run elasticities qualitatively confirmed prior results albeit being somewhat lower for the budget, cyclically adjusted and structural balance. The unconditional long-run elasticity for the primary balance was reasonably similar to the conditional counterpart in Table 1. Again, we found larger effects for the structural balance. While this exercise using unconditional fiscal elasticities does not change our main conclusions drawn from the thick modelling approach, Figure 1 highlights that different combinations of macro variables yield different short- and long-run coefficients. Thus, controlling for different fiscal-macro combinations and utilizing the information from all specifications helps to safeguard against pinpointing to a single best or even a handful of thin models.

4.3. Results for other control variables

Table 2 shows the medians across resulting distributions of the estimated coefficients for the control variable, whenever it appeared in one of the regressions. For the sake of brevity, we only discuss the results for the macro fundamentals, financial or other controls, which yielded the largest t-values on average, whereas we discarded the other predictors as their average t-values were significantly lower than two. The most robust predictors turned out to be the growth rate of disposable income, real short-term interest rate, GDP deflator and household debt. A borderline variable is the unemployment rate, which on average was significant in regressions with headline fiscal balances, but not with cyclically-adjusted measures. Given the lack of robustness across specifications, we thus abstract from interpreting the unemployment rates impact on household saving.

Overall, for these variables, our results are in line with broad theoretical predictions and empirical findings, albeit conclusions are not always clear in the literature. As described in *Callen and Thimann (1997)*, the impact of the real interest rate on saving is theoretically ambiguous because of opposing substitution and income effects (substitution effect means that lower real interest rates induce households to replace saving with consumption, inducing lower saving today; income effect means that lower real interest rate makes households richer, inducing an increase in the saving ratio). On balance, however, the empirical studies tend to find more evidence towards substitution effects (lower real interest rates inducing lower saving rates). Similarly, the effect of household indebtedness (and credit growth or financial development) is ambiguous in theory. Higher private debt may induce households to save more today to pay the debt in the future. At the same time, higher private debt may ease household liquidity constraints and induce them to consume more and save less today.

For disposable income growth we find positive coefficients, which are relatively close across models with different fiscal policy proxies. According to the medians of the various distributions of selected models, an increase in household disposable income growth by 1 percentage point (pp) raises the household saving ratio by around 0.36 to 0.40 pp. We also find a positive effect for the short-term interest rate, indicating that the saving ratio tends to rise when the real interest rate increases, with a median coefficient of around 0.12 to 0.14 pp. When looking at inflation measured by the GDP deflator, we find that an increase in inflation is associated with lower household saving in the euro area, with a median coefficient across models of around -0.16 to -0.18. Finally, a higher household debt ratio is found to be associated with a lower household saving ratio, with a median coefficient at about -0.05 to -0.06, possibly reflecting a (lower) income effect and/or lower liquidity constraints. As mentioned, similar "directional" relationships to household saving are unveiled in other studies for advanced economies, e.g., for income growth[14]

[14] *Mody et al. (2012)* finds a negative relationship between *lead* disposable income growth – as a measure of uncertainty and "precautionary" household saving (a reduction in income growth increases the saving rate). In line with our findings, but for total private saving rate, *Loayza et al. (2000)* find a positive and statistically significant coefficient for GDP per capita growth.

in *Callen and Thimann (1997)* and real short-term deposit rate in *Mody et al. (2012)*. Contrary to our findings, the impact of inflation is found to be either not statistically significant (in the cross-country analysis) or positive (in selected panel models) in *Callen and Thimann (1997)*. Yet, it is generally found to be negative and statistically significant in explaining total private saving in the more recent study of *Röhn (2010)*.

Table 2: Median coefficients of the most robust controls (baseline)

	Panel A: All trimmed models				*Panel B: Selected models*			
	Budget balance	*Primary balance*	*Cyclically adjusted primary balance*	*Structural balance*	*Budget balance*	*Primary balance*	*Cyclically adjusted primary balance*	*Structural balance*
Disposable income growth	0.325	0.336	0.323	0.323	0.388	0.398	0.357	0.365
	(4.355)	*(4.394)*	*(4.101)*	*(4.679)*	*(4.481)*	*(4.647)*	*(4.259)*	*(5.179)*
Real short-term interest rate	0.141	0.137	0.129	0.136	0.138	0.131	0.117	0.140
	(2.635)	*(2.599)*	*(2.424)*	*(2.233)*	*(2.559)*	*(2.441)*	*(2.14)*	*(2.376)*
GDP deflator	-0.160	-0.174	-0.181	-0.166	-0.158	-0.172	-0.179	-0.169
	(2.607)	*(2.721)*	*(2.861)*	*(3.026)*	*(2.601)*	*(2.706)*	*(2.825)*	*(3.162)*
Household debt	-0.049	-0.053	-0.046	-0.049	-0.055	-0.057	-0.053	-0.059
	(2.01)	*(1.957)*	*(1.812)*	*(2.158)*	*(2.193)*	*(2.089)*	*(2.026)*	*(2.517)*

Source: Authors' calculations. Notes: The table presents medians of estimated elasticities and their t-values based on robust standard errors in parentheses from the trimmed coefficient distributions using $\tau = 0.1$. *The dependent variable is gross household saving as a percentage of disposable income. Fiscal variables were treated as endogenous. Panel A refers to all estimated model specifications (5,827 trimmed for each fiscal measure). Panel B discards statistically mis-specified models in line with the criteria mentioned in Table 1 (the statistical significance criterion refers to the short run fiscal elasticity). The number of total observations, across both N and T, in our regressions using an unbalanced panel varies between 292 and 358 depending on data availability.*

5. Robustness checks

5.1 Other fiscal policy variables

We continue our empirical analysis with a battery of robustness checks. In a first robustness exercise we consider alternative measures of fiscal policy, i.e. cyclically adjusted budget balance, structural primary balance, fiscal stance and total discretionary measures based on ESCB/ECB estimates. The fiscal stance is computed as the first difference of the cyclically adjusted primary balance. The total discretionary measures variable is a bottom-up (measure by measure) proxy of discretionary fiscal policy measures.

We find very similar results compared to our baseline exercise for the cyclically adjusted balance and structural primary balance (Table 3). The bottom-up measure of the discretionary fiscal policy is found to be statistically significant in only a small proportion of models. Interestingly, the largest coefficients (in absolute terms) are found for the fiscal stance. Note that in these models, the short-run coefficients will now measure the magnitude of household saving response to a change in governments' consolidation (expansionary) efforts, that is, an acceleration coefficient. Although the short-run median elasticity (-0.26 for all trimmed models and -0.28 for the selected ones) is comparable in magnitudes to those of our structural fiscal indicators, the long run median elasticity is found to be extremely large (-1.09 and -1.25). This is a remarkable result, which implies that a one percentage point decrease in the fiscal stance – e.g., a larger fiscal expansion – over proportionally raises household savings by more than one percentage point on average in the long run. So far, we were able to confirm the existence of partial Ricardian equivalence for both the short and long run, but empirical results using the fiscal stance as a measure of (discretionary) fiscal policy point towards a full – or even over-proportionally – saving offset of fiscal consolidation efforts in the long run. However, given the higher uncertainty surrounding our long-term estimates for the fiscal stance, the true effect might even vary between +0.06 and -2.55 after accounting for estimation uncertainty (using two sigma confidence intervals based on the median standard error across selected models). The higher standard errors point to rather non-robust results for the fiscal stance in the long-run.

Table 3: Median fiscal elasticities (robustness, other fiscal policy variables)

	Panel A: All Trimmed Models				*Panel B: Selected Models*			
	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	$JR_{10\%}$	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	*NoM*
Cycl. adj. balance	-0.183	-0.416	93.2	73.8	-0.192	-0.441	97.6	4,302
Estimation uncertainty	*(0.062)*	*(0.153)*			*(0.061)*	*(0.157)*		
Model uncertainty	*-0.29/-0.12*	*-0.63/-0.27*			*-0.29/-0.13*	*-0.64/-0.31*		
Structural primary balance	-0.227	-0.503	88.1	65.2	-0.229	-0.520	88.7	3,794
Estimation uncertainty	*(0.081)*	*(0.168)*			*(0.079)*	*(0.168)*		
Model uncertainty	*-0.36/-0.14*	*-0.82/-0.33*			*-0.37/-0.14*	*-0.85/-0.34*		
Fiscal stance	-0.262	-1.094	68.3	75.8	-0.284	-1.245	86.6	4,415
Estimation uncertainty	*(0.091)*	*(0.602)*			*(0.086)*	*(0.652)*		
Model uncertainty	*-0.35/-0.07*	*-2.54/-0.27*			*-0.35/-0.11*	*-2.68/-0.48*		
Total discretionary measures	-0.029	-0.088	8.6	67.6	-0.083	-0.276	12.7	3,940
Estimation uncertainty	*(0.102)*	*(0.416)*			*(0.093)*	*(0.388)*		
Model uncertainty	*-0.17/0.14*	*-0.8/0.63*			*-0.18/0.05*	*-0.87/0.13*		

Source: Authors' calculations. Notes: See notes for Table 1. Fiscal stance measured in percentage points of GDP, other variables measured as percent of GDP.

We also checked for individual fiscal components by looking at government consumption and investment. However, while our baseline conclusions still hold, i.e. higher expenditures imply higher saving, the statistical significance for those models was much lower (below one-half of all models). In addition, we also tested total government expenditures and revenues, but again found rather inconclusive results. If anything, we found some evidence on the revenue side, i.e. lower revenues increase household saving, which is in line with higher saving in expectation of higher future taxes. In this respect, in our models, the evidence is found to be stronger for the overall balance of the government.

Last, but not least, we checked for the role of government debt, i.e. possible non-linearities in the response of saving to fiscal balances according to the level of debt. While a stronger Ricardian behaviour is found at higher debt levels in several studies (in relation to private saving or current account balances, e.g. in *Röhn (2010)* and *Nickel and Vansteenkiste (2008)*), we fail to unveil a robust relationship in our framework. On the one hand, when using interaction terms between fiscal balances and high debt regime dummies in our dynamic panel GMM model, we find a positive coefficient for the interaction term (a lower Ricardian offset at high debt levels). On the other hand, in models using the fixed effect estimator (see further robustness checks) and when splitting the sample in high and low debt countries, we find a higher private saving offset at high debt levels. We leave this topic for further research.

5.2. Data uncertainty

5.2.1 Alternative fiscal data sources and cyclical adjustments

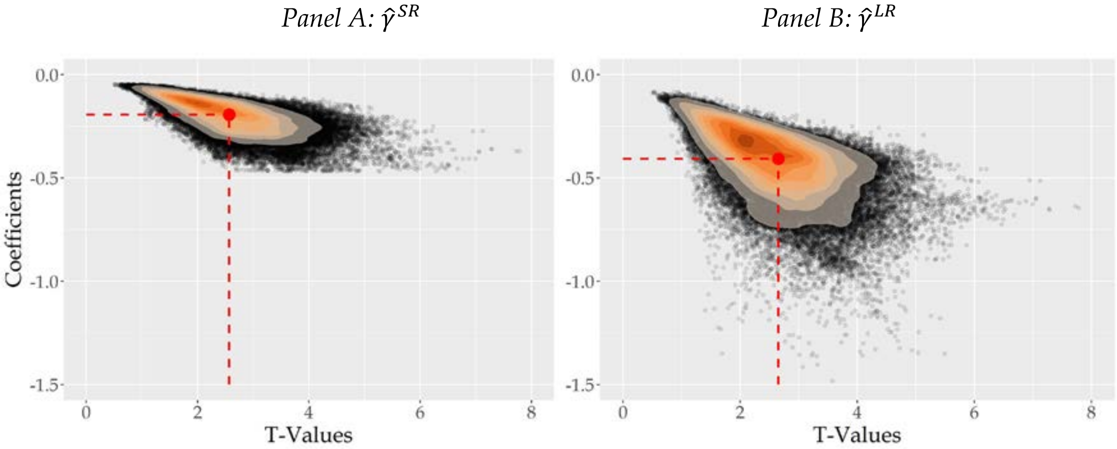
So far, we captured model and estimation uncertainty only. However, a third source of uncertainty with respect to the underlying data might also be relevant. Fiscal variables might differ slightly in their meta definitions and especially cyclically adjusted and structural fiscal indicators may differ in terms of their underlying adjustment procedures and potential output estimates (see, for example, *Goettert and Wollmershaeuser (2021)* for a discussion).

For these reasons, we repeat our thick modelling approach for different fiscal balance measures. We use data from three major policy institutions, namely the European Commission (EC), Organization for Economic Cooperation and Development (OECD) and the International Monetary Fund (IMF). For all organizations we collect the corresponding series for the budget balance and primary balance, and – where differences are expected to be larger – for the cyclically adjusted primary as well as structural balance estimates.[15]

Figure 2 plots the resulting distributions of estimated fiscal policy coefficients from 69,924 (untrimmed: 77,700) different model specifications. Here, we pool the coefficients from regressions including one (at the time) of the twelve different fiscal policy measures from the three institutions. In short, using these alternative fiscal data confirms our prior results. There seems to be a clear tendency pointing towards negative values for short term fiscal elasticities. The median short (long) run elasticity across all trimmed models is around -0.19 (-0.41). Median t-values are 2.57 and 2.65 for short- and long-run elasticities, respectively. Thus, this robustness test confirms our baseline results and supports the strong empirical evidence for a partial saving offset of fiscal stimulus in line with a Ricardian channel. As before, some fiscal-macro combinations do not rule out full budget neutralisation in the long run, but most of the coefficients mass is located well below unity.

[15] Due to data availability the collected data will slightly differ from our baseline regressions employing ESCB fiscal balance data. For example, for the OECD we only obtained data for 17 euro area countries, excluding Malta and Cyprus. Structural indicators collected from the European Commission only date back until 2003. For IMF fiscal measures we do not obtain data for Latvia and Lithuania prior to 2004.

Figure 2: Distribution of fiscal elasticites and t-values across all trimmed models (robustness, alternative fiscal data sources and cyclical adjustments)



Source: Authors' calculations. Notes: This figure plots estimated coefficients (y-axis) against their corresponding t-values (x-axis), as well as their their joint normalized bivariate kernel density using a Gaussian kernel and a rule-of-thumb selected bandwith parameter. All models estimated with Arellano-Bond GMM. The dependent variable is gross household saving as a percentage of disposable income. Fiscal variables (budget balance, primary balance, cyclically-adjusted primary balance and structural balance, all measured in percent of potential GDP) introduced one at the time in each model and treated as endogenenous. Panel A refers to estimated short run fiscal policy coefficients and corresponding t-values. Panel B plots model-implied long run fiscal policy coefficients and t-values. The number of trimmed models is 69,924 (untrimmed 77,700, with $\tau = 0.1$). Red dashed lines refer to the medians.

5.2.2 Household saving ratio as percent of GDP

In line with the variable of interest in the ESCB projections, we have investigated the determinants of household saving as percent of nominal disposable income. *Callen and Thimann (1997)* argue that household saving measured as percent of nominal GDP is preferable to fully capture the effects of fiscal policy. Thus, we repeat our baseline thick modelling framework employing this measure for the dependent variable household saving as percent of nominal GDP to safeguard against different measures in the denominator for the saving rate. For this reason, we use data from AMECO for gross household saving as percent of GDP.

While the results remain qualitatively the same, the economic significance decreases (Table 4). Overall, our median fiscal elasticities are somewhat slightly lower compared to our baseline results. We find again somewhat larger coefficients when using the structural balance as a measure of discretionary fiscal policy. In the short-run, a 1 pp decline in the structural balance is associated with 0.2 pp increase in the household saving ratio-to-GDP. The effect for the other fiscal variables is somewhat more than half (saving rate offset of about 10 - 13%). Note that, although we obtain fewer statistically well specified models when using household saving measured as percent of GDP, the results using all models are not altered when looking at the median coefficients for selected models. The latter are reasonably close to their full distributional counterparts. Thus, we confirm previous results.

Table 4: Median fiscal elasticities (robustness, gross household saving as percent of GDP)

	Panel A: All Trimmed Models				Panel B: Selected Models			
	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	$JR_{10\%}$	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	NoM
Budget balance	-0.111	-0.257	85.0	57.5	-0.120	-0.273	92.7	3,352
Estimation uncertainty	*(0.038)*	*(0.078)*			*(0.038)*	*(0.072)*		
Model uncertainty	*-0.18/-0.06*	*-0.38/-0.15*			*-0.18/-0.06*	*-0.38/-0.18*		
Primary balance	-0.091	-0.215	68.7	70.1	-0.097	-0.230	71.5	4,087
Estimation uncertainty	*(0.036)*	*(0.075)*			*(0.037)*	*(0.076)*		
Model uncertainty	*-0.16/-0.03*	*-0.35/-0.09*			*-0.16/-0.04*	*-0.34/-0.10*		
Cyclically adjusted primary balance	-0.102	-0.244	78.6	75.6	-0.109	-0.263	81.5	4,407
Estimation uncertainty	*(0.038)*	*(0.086)*			*(0.038)*	*(0.086)*		
Model uncertainty	*-0.17/-0.05*	*-0.39/-0.14*			*-0.17/-0.05*	*-0.39/-0.14*		
Structural balance	-0.198	-0.433	94.1	36.7	-0.206	-0.462	96.5	2,138
Estimation uncertainty	*(0.062)*	*(0.113)*			*(0.057)*	*(0.112)*		
Model uncertainty	*-0.30/-0.12*	*-0.63/-0.31*			*-0.30/-0.12*	*-0.65/-0.34*		
Cycl. adj. balance	-0.127	-0.297	90.3	72.5	-0.134	-0.310	95.9	4,224
Estimation uncertainty	*(0.045)*	*(0.094)*			*(0.043)*	*(0.087)*		
Model uncertainty	*-0.20/-0.07*	*-0.42/-0.20*			*-0.20/-0.07*	*-0.42/-0.21*		

Source: Authors' calculations. Notes: See notes for Table 1. Fiscal stance measured in percentage points of GDP, other variables measured as percent of GDP. The dependent variable is gross household saving as a percentage of nominal GDP.

5.3 Alternative estimator

An additional robustness exercise estimates a static relationship between household saving and fiscal policy using the fixed-effect least squares estimator, with heteroscedasticity robust standard errors (clustered at country level). In addition to country fixed effects, we also control for common developments across countries with time fixed effects.

Although the interpretation of the coefficients is different (the short-and long-run coefficients are assumed to be the same, ranging between -0.2 to -0.4), the overall picture is not altered (Table 5). Fiscal expansions in the euro area are associated with increased household saving. Thus, this robustness check confirms our previous findings which point to empirical support for a partial saving offset of fiscal stimulus in line with the existence of a partial Ricardian equivalence channel. Fiscal elasticities are highly significant across almost all model specifications. In line with our baseline findings the structural balance displays somewhat larger saving offsets of fiscal stimulus.

The adjusted R-squared in these fixed-effect models is relatively small with median values between 21 and 26% depending on the specific fiscal policy measure at hand. The set of models employing the structural balance to proxy (discretionary) fiscal policy appear to be among those models with the highest share of explained variance for household saving. In fact, in our thick modelling approach, which only allows six macro variables at maximum to enter a model jointly, the best performing model by means of adjusted R-squared (35%) is a model employing the structural balance and six macro variables (short-term interest rate, household debt, unemployment rate, dependency ratio, total population growth, equity index).[16] This is not too surprising, as a large fraction of the variance is typically explained by one-period lagged saving.[17]

Table 5: Median fiscal elasticities (robustness, static panel fixed-effect estimator)

	Panel A: All Trimmed Models			*Panel B: Selected Models (AIC)*			
	γ	$SR_{5\%}$	R^2	γ	$SR_{5\%}$	R^2	NoM
Budget balance	-0.265	94.2	22.2	-0.293	100.0	24.6	583
Estimation uncertainty	*(0.094)*			*(0.083)*			
Model uncertainty	*-0.33/-0.19*			*-0.33/-0.21*			
Primary balance	-0.221	85.1	20.0	-0.242	99.1	22.0	583
Estimation uncertainty	*(0.095)*			*(0.087)*			
Model uncertainty	*-0.27/-0.17*			*-0.27/-0.18*			
Cyclically adjusted primary balance	-0.245	96.3	20.8	-0.257	100.0	23.1	583
Estimation uncertainty	*(0.098)*			*(0.088)*			
Model uncertainty	*-0.28/-0.20*			*-0.29/-0.22*			
Structural balance	-0.430	100.0	26.4	-0.442	100.0	28.8	583
Estimation uncertainty	*(0.124)*			*(0.120)*			
Model uncertainty	*-0.48/-0.37*			*-0.48/-0.39*			
Cycl. adj. balance	-0.283	100.0	23.5	-0.293	100.0	24.6	583
Estimation uncertainty	*(0.087)*			*(0.083)*			
Model uncertainty	*-0.33/-0.24*			*-0.33/-0.21*			

Source: Authors' calculations. Notes: The table presents medians of estimated elasticities and their cluster-robust standard errors in parentheses from the trimmed coefficient distributions using $\tau = 0.1$ (fiscal balances measured as percent of GDP). The dependent variable is gross household saving as a percentage of disposable income. Panel A refers to all estimated model specifications (5,827 trimmed and 6.574 untrimmed for each fiscal measure). Panel B discards statistically mis-specified models and selects the ten percent best performing models based on the AIC. Model uncertainty refers to 5th and 95th quantile of the estimated coefficient distribution. $SR_{5\%}$ refers to the significance ratio, i.e. the share of significant short run fiscal policy coefficients at 5%. R^2 refers to adjusted R-squared. NoM refers to the number of models remaining after model selection. The number of total observations, across both N and T, in our regressions using an unbalanced panel varies between 292 and 358 depending on data availability.

In terms of model selection, if we allow only for the best 10% of models in terms of in-sample fit by means of the AIC criteria (which penalizes models with more predictors), the results remain almost the same with only slightly larger fiscal coefficients.

These results are broadly in line with previous studies (see Table A.1 in the appendix), which typically report empirical evidence for partial budget neutralisations, but fail to report evidence for full saving offsets. For example, when comparing our results with other studies that directly look at household savings using a static estimation framework. *Mody et al. (2012)* find partial saving offsets of around 21% in their baseline results and between 20 and 54% in their robustness analysis when using the structural balance. *Callen and Thimann (1997)* report a saving neutralisation of around 40% when employing headline budget balance to measure fiscal policy, which is

[16] Even in models with all fourteen variables included the unadjusted R-squared is only close to 42% (adjusted: 35%). From this exercise we conclude that one can be relatively certain that one – or at least a few – macro and fiscal combinations already cover a reasonably high share of the overall explained variance, at least when compared to the maximum model which employs all possible macro predictors jointly.

[17] *Afonso and Coelho (2020)*, who empirically study Ricardian equivalence hypothesis in EU countries focusing on current account balances as percent of GDP, find R-squares between 30 and 60% in their fixed-effect models. In our model, when measuring gross household saving as percent of GDP, the maximum model with fourteen macro predictors yields R-squares between 49 and 54% (adjusted: 43 and 48%).

somewhat higher than ours (note that they also use saving as percent of GDP, for which we have found lower offset coefficients).

5.4 Private saving

Most of the empirical literature that investigates the role of fiscal policy for savings focus on total private saving. For this reason, we repeat our thick modelling GMM approach using total private saving as percent of GDP drawn from European Commissions' AMECO database.

Table 6 presents the results. Two aspects stand out. First, we obtain only a low share of significant fiscal elasticities in conjunction with a moderate share of models passing standard GMM selection criteria. Second, when looking at the relatively few models which pass our selection criteria, we find similar short-run elasticities compared to our baseline using household saving, i.e. fiscal stimulus is offset in the short-run at a rate of about 12 to 14% for fiscal measures other than the structural balance, while for the latter the median offset rate is at 24%. The long run private saving offset is lower compared to the baseline for all variables, at around at 30% for the structural balance and 18 to 22% for the others.

Table 6: Median fiscal elasticities (robustness, total private saving)

	Panel A: All Trimmed Models				*Panel B: Selected Models*			
	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	$JR_{10\%}$	$\hat{\gamma}^{SR}$	$\hat{\gamma}^{LR}$	$SR_{5\%}$	*NoM*
Budget balance	-0.134	-0.201	7.5	19.3	-0.138	-0.222	11.8	1,098
Estimation uncertainty	*(0.123)*	*(0.174)*			*(0.126)*	*(0.183)*		
Model uncertainty	*-0.23/-0.08*	*-0.3/-0.12*			*-0.24/-0.07*	*-0.32/-0.12*		
Primary balance	-0.132	-0.201	12.1	14.3	-0.130	-0.209	14.2	775
Estimation uncertainty	*(0.111)*	*(0.166)*			*(0.118)*	*(0.185)*		
Model uncertainty	*-0.24/-0.08*	*-0.3/-0.13*			*-0.25/-0.08*	*-0.32/-0.13*		
Cyclically adjusted primary balance	-0.122	-0.181	5.4	16.2	-0.119	-0.178	6.4	769
Estimation uncertainty	*(0.126)*	*(0.185)*			*(0.138)*	*(0.202)*		
Model uncertainty	*-0.22/-0.07*	*-0.28/-0.11*			*-0.22/-0.07*	*-0.28/-0.11*		
Structural balance	-0.232	-0.269	10.8	25.4	-0.254	-0.295	20.1	1,412
Estimation uncertainty	*(0.195)*	*(0.215)*			*(0.187)*	*(0.204)*		
Model uncertainty	*-0.37/-0.16*	*-0.41/-0.19*			*-0.38/-0.18*	*-0.42/-0.2*		
Cycl. adj. balance	-0.128	-0.187	1.0	22.5	-0.133	-0.195	1.0	1,127
Estimation uncertainty	*(0.148)*	*(0.21)*			*(0.156)*	*(0.217)*		
Model uncertainty	*-0.21/-0.07*	*-0.27/-0.11*			*-0.22/-0.07*	*-0.28/-0.11*		

Source: Authors' calculations. Notes: The table presents medians of estimated elasticities and their robust standard errors in parentheses from the trimmed coefficient distributions using $\tau = 0.1$ (fiscal balances measured as percent of GDP). Standard errors for the model-implied long run coefficients were computed using the Delta-method. The dependent variable is private saving as percent of nominal GDP. Fiscal variables were treated as endogenous. Panel A refers to all estimated model specifications (5,827 trimmed and 6.574 untrimmed for each fiscal measure). For model selection criteria, see Notes to Table 1. The number of total observations, across both N and T, in our regressions using an unbalanced panel varies between 292 and 361 depending on data availability.

Compared to the literature, these coefficients seem to be on the lower side, apart from one study. *Loayaza (2000)*, who use dynamic setup and system-GMM estimator, find total private saving offsets for their OECD sample using the headline budget balance as a measure of fiscal policy that are lower than ours in the short-run (at 10%) and similar in the long-run (at 34%). *Mello et al. (2004)*, who use the same estimator for their partial adjustment model than we do, find private saving offsets of fiscal stimulus, measured by the cyclically-adjusted balance, of around 30 and

90% in the short- and long-run, respectively. *Röhn (2010)* finds a private saving offset of 40% in both the short and long-run.

These results should be, however, interpreted with caution. As our FD-GMM models may not be statistically well enough specified for modelling the total private saving ratio or the evidence too weak, we conclude that we do not find robust evidence for the partial Ricardian equivalence when looking at the effects of fiscal expansions onto total private saving.

6. Conclusions

This paper empirically analyses the effect of fiscal policy on household saving in the euro area, i.e. testing for Ricardian equivalence, based on a thick modelling approach. We consider multiple dynamic panel data models rather than relying only on a few possible candidate models, as typically done in the literature. This allows dealing with model and estimation uncertainty, while at the same time being agnostic about both the specific fiscal policy proxy at hand as well as the set of macro fundamentals, financial, demographic and other variables employed as controls.

Our main results can be summarized as follows. First, we find empirical evidence for a partial household saving offset of fiscal stimulus, with a median value of 19% in the short run and 41% in the long run. While the magnitude of the effects varies depending on the specific fiscal policy proxy at hand, this partial offset is regardless of how we measure fiscal policy. Overall, we do not find empirical evidence for the existence of a strict version of the Ricardian equivalence in the euro area, i.e. a full saving offset of fiscal stimulus in the short run. Although some fiscal-macro combinations in our thick modelling approach do not rule out full saving offsets in the long-run, most of the probability mass for our fiscal elasticities is located well below unity. This supports the idea of learning about the relationship between fiscal policy and household saving by using many different model specifications.

Second, in terms of additional results and robustness checks, we find the following. Disposable income, real short-term interest rate, GDP deflator and household debt turn in our thick-modelling approach to be the most robust variables among a larger set of potential determinants for the household saving ratio identified in the literature. Various robustness checks – in terms of alternative data, fiscal indicators and estimators – broadly support our results with respect to household savings. On the other hand, the evidence for the relationship between fiscal policy and *total private* saving is weak and not robust enough in our model.

Third, our results for the euro area are broadly in line with the literature for the advanced economies, albeit they tend to yield a somewhat weaker evidence for the saving offset of fiscal policy, particularly in relation to earlier studies or as regards the total private saving offset. This may point to an increased effectiveness of fiscal policy for short-run stabilization.

The usual cautionary remarks when drawing causal inferences with macroeconomic data applies to our findings. In addition to tackling model uncertainty, we attempt to mitigate the problem of endogeneity of fiscal variables by using the Arellano-Bond GMM estimator.

Areas for future research include a more in-depth investigation of the relationship to government debt, the differences in results between household and total private saving and quantifying the role of fiscal policy versus other determinants of saving.

References

Afonso, Antonio and Jose Carlos Coelho (2021). The role of fiscal policies for external imbalances: Evidence from the European Union. EconPol Working Paper, 57.

Aiolfi, Marco and Carlo A. Favero (2005). Model uncertainty, thick modelling and the predictibility of stock returns. Journal of Forecasting, 24(4), p. 233-254.

Anderson, T.W. and Cheng Hsiao (1981). Estimation of dynamic models with error components. Journal of the American Statistical Association, 76(1), p. 598-606.

Anderson, T.W. and C. Hsiao (1982). Formulation and estimation of dynamic models using panel data. Journal of Econometrics, 18(1), p. 47-82.

Arellano, Manual and Olympia Bover (1995). Another look at the instrumental variables estimation of error components models. Journal of Econometrics, 68(1), p. 29-51.

Arellano, Manuel (1989). A note on the Anderson-Hsioa estimator for panel data. Economics Letters, 31(1), p. 337-341.

Arellano, Manuel and Stephen Bond (1991). Some test of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies, 58(2), p. 277-297.

Barro, Robert J. (1974). Are government bonds net wealth?. Journal of Political Economy, 82, p. 1095-1117.

Barro, Robert J. (1989). The Ricardian Approach to Budget Deficits. Journal of Economic Perspectives, 3(2), p. 37–54.

Blundell, Richard and Stephen Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87(1), p. 115-143.

Callen, Tim and Christian Thimann (1997). Empirical determinants of household saving: Evidence from OECD countries. IMF Working Paper, 97/181.

Ca'Zorzi, Michele, Alexander Chudik, and Alistair Dieppe (2012). Thousands of models, one story: current account imbalances in the global economy. Journal of International Money and Finance, 31(6), p. 1319-1338.

Cho, Dooyeon and Ju Hyun Pyun (2019). Measuring the time-varying effects of fiscal policy on private saving in the process of financial integration. Review of International Economics, 28(1), p. 82-104.

de Bondt, Gabe Jacob, Arne Gieseck, and Zivile Zekaite (2020). Thick modelling income and wealth effects: a forecast application to euro area private consumption. Empirical Economics, 58, p. 257-286.

de Bondt, Gabe Jacob, Arne Gieseck, Pablo Herrero, and Zivile Zekaite (2019). Disaggregate income and wealth effects in the largest euro area countries. ECB Working Paper, No. 2343.

de Mello, Luiz, Per Mathis Kongsrud and Robert Price (2004). Saving behaviour and the effectiveness of fiscal policy. OECD Working Paper, 397.

de Serres, Alain and Florian Pelgrin (2002). The decline in private saving rates in the 1990s in OECD countries: How much can be explained by non-wealth determinants?. OECD Working Paper, 344.

ECB (2021): "June 2021 ESCB staff macroeconomic projection exercise". European Central Bank, https://www.ecb.europa.eu/pub/projections/html/index.en.html.

Goettert, Marcell and Timo Wollmershaeuser (2021). Survey-based structural budget balances. EconPol Working Paper, 59.

Granger, Clive and Yongil Jeon (2004). Thick modelling. Economic Modelling, 21(2), p. 323-343.

Hüfner, Felix and Isabell Koske (2010). Explaining household saving rates in G7 countries: Implications for Germany. OECD Working Paper, 754.

Loayza, Norman, Klaus Schmidt-Hebbel and Luis Servén (2000). What drives private saving across the world?. The Review of Economics and Statistics, 82(2), p. 165-181.

McAdam, Peter and Paul McNelis (2004). Forecasting inflation with thick models and neural networks. Economic Modelling, 22(5), p. 848-867.

Mody, Ashoka, Franziska Ohnsorge and Damiano Sandri (2012). Precautionary savings in the great recession. IMF Working Paper, 12/42.

Nickel, Christiane and Isabel Vansteenkiste (2008). "Fiscal policies, the current account and Ricardian equivalence", ECB Working Paper no. 935.

Röhn, Oliver (2010). New evidence on the private saving offset and Ricardian equivalence. OECD Working Paper, 762.

Roodman, David (2009a). How to do xtabond2: An introduction to difference and system GMM in Stata. Stata Journal, 9(1), p. 86-136.

Roodman, David (2009b). A note on the theme of too many instruments. Oxford Bulletin of Economics and Statistics, 71(1), p. 135-158.

Tanzi, Vito and Howell H. Zee (1998). Taxation and the household saving rate: Evidence from OECD countries. IMF Working Paper, 98/36.

Table A1: Review of studies investigating the impact of fiscal policy on household and total private saving in advanced economies

Paper	Title	Sample		Main Econometric Method	Proxy public saving and other fiscal vars	Other controlled variables	Partial Ricardian Equivalence (RE) (private public saving offset)	Main conclusions on impact of fiscal policy on private saving
		Countries	Period					
Dependent variable: Household (HH) saving ratio								
Mody, Ohnsorge and Sandri (2012)	Precautionary Savings in the Great Recession	24 OECD countries	Unbalanced panel (1980-2010), for most countries: 1995-2009	Static panel model, Fixed-effects (FE) (alternatively, random-effects)	*Structural budget balance (% of potential GDP)*	Unemployment rate, disposable income growth, GDP volatility, financial worth, real short-term deposit rate, global variables (e.g., real GDP growth)	In static model, assumed long-run (LR) = short run (SR) = -0.21 (range robustness checks -0.2 to -0.3 with yearly data; but at -0.54 with 3-year average data)	Fiscal policy variable used only as control, but highly statistically significant (stat.sig.) and robust. Main focus: Model of precautionary savings under of uncertainty finding that at least 2/5 of the sharp increase in household saving rates over 2007-09 can be attributed to the precautionary savings motive (1/5 explained by the increase in the structural deficit).
Tanzi and Zee (1998)	Taxation and the household saving rate: Evidence from OECD countries	21 OECD countries	1970 - 1994	Static panel model, OLS (level, log, first difference)	Total tax revenue, income tax revenue, incl. social sec. contributions, consumption tax revenue (all ratios to GDP)	-	Analysis only on the tax side supporting partial RE.	Shares of total and income taxes in GDP have a highly stat.sig. and negative impact on household saving rate. The impact of consumption taxes quantitatively less pronounced, but remains stat.sig.
Callen and Thimann (1997)	Empirical determinants of household saving: Evidence from OECD countries	21 OECD countries	1975 - 1995	Cross Section and static panel model, FE (robustness checks with various FE estimators)	*Budget balance (in % of GDP as a proxy for public saving),* + direct and indirect taxes, transfers (ratios to GDP)	Ratio of corporate saving, income per capita, disposable income growth, unemployment rate, ex-post real interest rate, inflation rate, old-age dependency ratio, direct and indirect taxes, transfers, outstanding consumer debt, outstanding credit cards per capita	Cross-sectional regressions: assumed LR = -0.8 to -0.9 Static panel model: assumed LR = SR = about -0.4	In addition to confirming partial RE, structure of tax and social security contributions influences HH saving rate (strong impact from direct taxes, but no stat. sig. impact from indirect taxes)
Dependent variable: Total private saving ratio								
Cho and Pyun (2019)	- Measuring the time varying effects of fiscal policy on private saving in the process of financial integration	Panel(s) of 23 advanced economies and 64 emerging and developing economies	1970 - 2010	Panel smooth transition regression (PSTR) model, with FE (transition variable: international financial integration index measured as the ratio of external assets and liabilities to GDP)	Estimated unanticipated current fiscal balanced (public saving) based on two step-country specific regressions	- - Log of per capita real GDP, per capita real GDP growth rate, young and old-age dependency ratios	For AEs sample: time and regime changing offset coefficients declining from -0.7 to -0.5.	The pattern of saving offset differs remarkably between advanced (AEs) and developing economies, according to the level of international financial integration. In AEs, the estimated offset coefficients gradually decrease over time, meaning that fiscal policy has become more effective (or the negative wealth effects of fiscal policy have decreased) in the process of international financial integration. Yet, in AEs, the offset coefficients range from -0.71 to -0.54 over time, confirming partial RE. In general, the paper finds a similar pattern, with only small variations across AEs over time (an example is given for the US, with the offset coefficient estimated at -0.71 in 1976 and -0.54 in 2010).

Paper	Title	Sample		Main Econometric Method	Proxy public saving and other fiscal vars	Other controlled variables	Partial Ricardian Equivalence (RE) (private public saving offset)	Main conclusions on impact of fiscal policy on private saving
		Countries	Period					
Dependent variable: Total private saving ratio (cont.)								
Roehn (2010)	New evidence on the private saving offset and Ricardian equivalence	16 OECD countries	1970:2 - 2008:4 (Quarterly)	Autoregressive distributed lag (ARDL) model in error correction form (ECM) - for panel: Mean Group (MG) estimator	*Cyclically-adjusted budget balance (% of potential GDP)* + components (total revenue, total expenditure, investment)	Old-age dependency ratio, broad money supply, the real short-term interest rate, the inflation rate, productivity growth, terms of trade changes and equity and house prices as proxies for wealth	SR = about -0.4 LR = about -0.4	Private saving offset is around 40% on average across countries in both the short and the long term, which is somewhat lower than found in prior research. However, the estimates vary considerably across countries. Changes in current revenues are almost fully offset, whereas offsets to current spending are on average around one third to one half depending on the sample. There is no offset for public investment. Saving offsets are stronger the higher the level of government debt and the better developed financial markets are.
Mello, L. de, M. Kongsgrud and R. Price (2004)	Saving behaviour and the effectiveness of fiscal policy	16 OECD countries	1970 - 2002	Dynamic Panel Models (ECM and partial equilibrium model), with Difference GMM (Arellano-Bond) estimator	*Cyclically-adjusted budget balance (% of potential GDP)* + components (total revenue, total expenditure, investment)	Broad money supply, terms of trade, old-age dependency ratio, per capita GDP growth, housing price index, equity market index	ECM: SR = about -0.5 LR = about -0.7 Partial equilibrium (lagged DV) model: SR = about -0.3 LR = about -0.9 Control for FE static model: LR = SR = -0.5	Strong evidence of partial, yet substantial, offsetting movements in aggregate private and public saving. This is consistent with a marked degree of anticipatory private sector behaviour compared to usual ex ante saving "leakage" embedded in the pure Keynesian models, which are smaller and apply only to revenues and transfers. Saving offset, surprinsingly, found to be smaller at higher debt (>70% of GDP), one explanation being the association with the high inflation from the early period and the perception of an existing "inflation tax" .
De Serres and Pelgrin (2002)	The decline in private saving rates in the 1990s in OECD countries: how much can be explained by non-wealth determinants?	15 OECD countries	1970- 2000	Dynamic panel model (ECM), with Pooled mean group (PMG) estimator	Gross public savings (*budget balance + public investment*) as % of GDP	Old age dependency, real interest rate, CPI inflation, terms of trade changes, growth rate of labour productivity	LR = 0.7 (SR lower, not reported) (result with preferred estimator PMG in between static FE at -0.5 and dynamic FE at -0.9)	Strong evidence of partial RE, but reject full RE. The sharp decline in the private saving rate between 1995-2010 can be largerly explained by fudamentals other than financial wealth. The rise in public sector saving is found to have contributted the most to the decline in private savings.
Loayza, Schmidt-Hebbel and Servén (2000)	What Drives Private Saving Across the World?	Large World Bank dataset of max.150 countries (20 OECD countries)	1965-1994	Dynamic Panel Model, with System GMM (Arellano-Bover/Blundell-Bond) estimator (among others)	*Budget balance (ratio to GPDI, Gross Private Disposable Income)*	Log level and growth of real per capita income, terms of trade, M2 to GNP, private credit flow to income, real interest rate, old age and young age dependency ratio, inflation rate, urbanization ratio	For the OECD sample: SR = about -0.1 LR = about -0.34 (LR hereby re-calculated based on Table 5; LR coefficient reported only for whole sample at 0.7)	Fiscal policy is a moderately effective tool to raise national saving. The evidence points against full Ricardian equivalence.

Source: Authors' representation. Notes: For comparability with our results, the table presents selected studies (for total private saving rate, the more recent) investigating the direct impact of fiscal policy on the saving rate. It does not include studies whose main focus is the impact of fiscal policy on private consumption, output or current account balance. It covers panel data studies on advanced economies (or including sub-sample of advanced economies) and not individual country analyses.

Table A2: List of variables, data transformation and descriptive statistics (baseline models)

	Variable	Unit (transformation)	Mean	Me-dian	SD
		Dependent Variable			
1	Gross household saving ratio	% of disposable income	9.8	10.0	5.9
		Fiscal Policy			
1	Cyclically adjusted primary balance	% of GDP	0.1	0.4	3.2
2	Structural balance	% of GDP	-2.1	-1.7	3.0
3	Budget balance	% of GDP	-2.4	-2.1	3.7
4	Primary balance	% of GDP	-0.1	0.2	3.4
		Macroeconomic and other indicators			
1	Real GDP	%, growth rate	2.5	2.4	3.7
2	Output gap	% of potential GDP	-0.2	0.0	3.2
3	Gross disposable income	%, growth rate	4.3	3.8	4.8
4	Unemployment rate, total	% of civilian employment	8.9	7.9	4.6
5	GDP deflator	%, growth rate	2.2	1.9	2.4
6	Household sector debt	% of GDP	52.1	50.8	27.3
7	Total factor productivity, total economy	%, growth rate	0.8	0.8	2.7
8	Terms of trade goods and services	%, growth rate	0.1	0.0	1.8
9	Real short-term interest rates	%	0.0	-0.3	2.8
10	Nominal long-term interest rates	%	3.9	4.1	2.5
11	Old-age dependency ratio	% of total population	16.6	16.8	2.7
12	Total population	%, growth rate	0.4	0.4	0.9
13	Economic sentiment indicator	Index	99.9	101.2	9.1
14	Equity price index	%, growth rate	5.4	7.4	28.9

Notes: The main source of data for the basic model is ECB/ESCB database (December 2020 Broad Macroeconomic Projection Exercise) or ECB Statistical Data Warehouse (SDW). Other data taken from the European Commission's AMECO database and Eurostat (e.g., Economic sentiment indicator, Household sector debt).

Table A3: List of variables, data transformation and descriptive statistics (robustness models)

	Variable	Unit (transformation)	Mean	Me-dian	SD
		Dependent Variable			
1	Gross household saving rate	% of GDP	5.9	6.3	3.5
2	Total private saving rate	% of GDP	20.2	20.9	4.9
		Fiscal Policy (AMECO)			
1	Cyclically adjusted primary balance	% of potential GDP	0.0	0.2	3.1
2	Structural balance	% of potential GDP	-2.1	-1.8	2.8
3	Budget balance	% of potential GDP	-2.4	-2.2	3.7
4	Primary balance	% of potential GDP	0.0	0.2	3.4
		Fiscal Policy (OECD)			
1	Cyclically adjusted primary balance	% of potential GDP	0.5	0.7	3.0
2	Structural balance	% of potential GDP	-1.5	-1.1	2.9
3	Budget balance	% of potential GDP	-2.0	-1.5	3.4
4	Primary balance	% of potential GDP	-0.3	0.0	3.0
		Fiscal Policy (IMF)			
1	Cyclically adjusted primary balance	% of potential GDP	0.0	0.2	2.8
2	Structural balance	% of potential GDP	-2.0	-1.7	3.1
3	Budget balance	% of potential GDP	-2.2	-2.1	3.6
4	Primary balance	% of potential GDP	-0.3	0.0	3.2

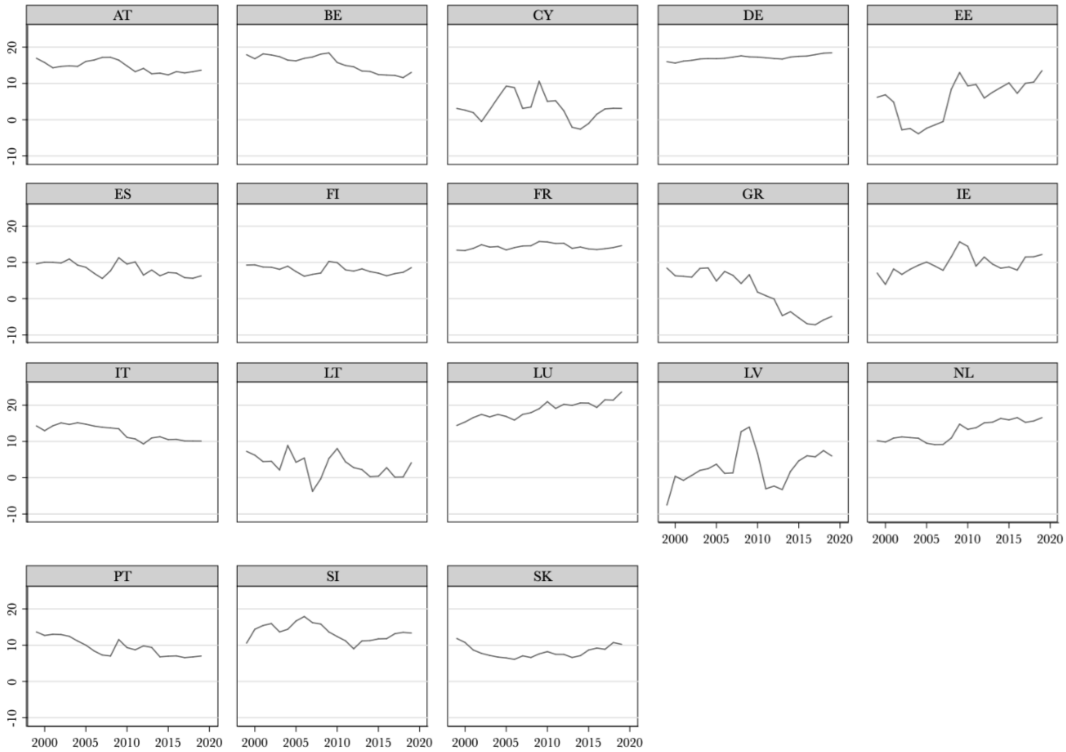
Notes: The source of data is European Commission's AMECO databases, Organization for Economic Co-operation and Development (OECD) Economic Outlook and International Monetary Fund (IMF) World Economic Outlook database. Gross household saving and total private saving are taken from AMECO.

Table A4: Regression summary statistics (baseline)

	Panel A: All trimmed models					Panel B: Selected models			
	$\hat{\rho}$	$SR_{10\%}$	$SR_{5\%}$	$SR_{01\%}$	$JR_{10\%}$	$\hat{\rho}$	NoM	NT_{min}	NT_{max}
Budget balance	0.557	97.7	91.4	76.2	76.1	0.560	4437	292	358
Estimation uncertainty	*(0.092)*					*(0.089)*			
Model uncertainty	*0.41/0.67*					*0.44/0.68*			
Primary balance	0.553	86.9	73.8	53.8	79.3	0.556	4620	292	358
Estimation uncertainty	*(0.099)*					*(0.097)*			
Model uncertainty	*0.40/0.67*					*0.43/0.68*			
Cyclically-adjusted primary balance	0.554	90.5	78.2	60.6	79.4	0.558	4627	292	357
Estimation uncertainty	*(0.099)*					*(0.096)*			
Model uncertainty	*0.40/0.66*					*0.43/0.66*			
Structural balance	0.542	99.5	97.4	89.0	57.1	0.565	3328	292	357
Estimation uncertainty	*(0.094)*					*(0.094)*			
Model uncertainty	*0.38/0.67*					*0.41/0.68*			

Source: Authors calculations. Notes: The table presents medians of estimated autoregressive parameters, $\hat{\rho}$, and their robust standard errors in parentheses from the trimmed coefficient distributions using $\tau = 0.1$ (fiscal balances measured as percent of GDP). Model uncertainty refers to 5th and 95th quantile of the estimated coefficient distribution. The dependent variable is gross household saving as a percentage of disposable income. Fiscal variables were treated as endogenous. Panel A refers to all estimated model specifications (5,827 trimmed and 6.574 untrimmed for each fiscal measure). Panel B discards statistically mis-specified models and selects only those models which jointly pass both Arellano-Bond autocorrelation tests (i.e. existence of first- but no second-order autocorrelation of residuals in first differences), as well as the Sargan test for overidentifying restrictions (H_0: Instruments as a group are exogenous). $SR_{x\%}$ refers to the significance ratio, i.e. the share of significant short run fiscal policy coefficients at 10, 5 and 1%, respectively. $JR_{10\%}$ refers to the ratio of models with Sargan overidentifying test p-values greater than 10% (H_0: Instruments as a group are exogenous). The number of total observations, across both N and T, in our regressions using an unbalanced panel varies between 292 and 358 depending on data availability.

Figure A1: Household saving to disposable income ratio by country



Notes: Gross household saving ratio measured as percentage of disposable income (y-axis). Data for Malta not available. In our empirical analysis, the country is included in the panel, based on internal ESCB estimates.

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